

BEST OF THE BLOGS

HYPERLOOP

HYPERLOOP PART I: A \$100 BILLION BOONDOGGLE?

Critics claim Hyperloop will cost \$60-100 billion, Elon Musk says \$6. A thorough cost analysis demonstrates that it will likely cost around \$11 billion.

2014/01/15 | Michael Zawalsky



When Elon Musk, the modern day Howard Hughes (or real life Tony Stark), [unveiled](#) his “Hyperloop” concept in August, he made a series of bold claims about how this “fifth mode of transport” would revolutionize the world. It would not only be faster and cleaner than conventional air, land and sea travel – it would be dramatically cheaper, too. It was this last benefit that would make the Hyperloop, first proposed for the San Francisco-Los Angeles’s corridor, impossible for governments, industrialists and Big Business to resist. Now that the [hype](#) and [hysteria](#) surrounding the announcement have died down, I thought it an appropriate time to investigate these claims.

Musk estimates that it would cost \$6 billion to build the passenger version of Hyperloop from San Francisco to Los Angeles (with costs increasing to \$7.5 billion for the vehicle version); however, others have estimated the true cost would range from [\\$60-100](#) billion. Despite accusations that Musk’s costs are wildly inaccurate, as best I can tell, no one has provided detailed independent cost analysis of Hyperloop. Leaving aside the many engineering hurdles that have yet to be cleared, my best estimate is that the true cost for Hyperloop, as proposed, would range from \$6.1 billion to \$9.8 billion. This estimate does not include extending Hyperloop deeper into the core of Los Angeles, which would likely increase total project cost to \$6.6-11.2 billion. Due to the complexity of the project, to do a true cost analysis on any on component of Hyperloop would likely be the work of a thesis project; and given the highly variable nature of costs in civil engineering projects, the new applications and combinations of technologies, the conservative assumption is to assume Hyperloop will fall towards the high end of that range.

While this estimate is close to Musk’s estimate, the potential for up to an 80% rise in cost would destroy Musk’s promise of a \$20 one-way ticket, and potentially the competitiveness of the Hyperloop.

Cost Analysis

Cost (US\$ million)	Musk	MZ Low	MZ High
Capsules	\$54	\$147	\$159
Tube	650	1,650	2,480
Pylons	2,550	2,049	2,697
Permits & Land	1,000	117	630
Tunneling	600	468	1,052
Propulsion	140	140	175
Solar Panels & Batteries	210	290	530
Station & Vacuum Pumps	260	760	1,010
Cost Margin	536	300	500
Total	6,000	6,093	9,797

For a more detailed breakdown of each line item of the passenger Hyperloop, click on the relevant header to expand:

Capsules
Tube

Pylons
Permits & Land
Tunnelling
Propulsion & Batteries
Solar Panels
Station + Vacuum Pumps
Cost Margin

A Tube to Nowhere?

The problem with Musk’s cost estimate is that the current Hyperloop only technically connects SF and LA. Critics have noted that to get from downtown LA to downtown SF, taking Hyperloop would be a longer journey than using CHSR. For a viable system to be put in place, Hypeloop’s route would need to be extended further into LA further increasing costs. This extension would increase travel times by roughly 5 minutes.

Many of the costs for Hyperloop will scale linearly; however, several design modifications would be beneficial. The 45km stretch of land purchases required would potentially yield a cost of between \$1.5-3 billion dollars. Adding a significant cost to the overall project. Instead it is recommended that Hyperloop be tunneled to downtown LA, eliminating the need for land purchases and removing any additional pylon costs, for a overall tunneling cost between \$315-1,035 million. Station costs would also increase by up to \$100 million to allow for an underground portion for the station.

This yields the following expected cost increases to add the segment of new line from Sylmar (current proposed terminus) to Downtown Los Angeles (DT LA):

Cost	Sylmar-DT LA Low	Sylmar-DT LA High
Capsules	\$22	\$24
Tube	132	198
Pylons	0	0
Permits & Land	0	0
Tunneling	315	1,035
Propulsion	11	14
Solar Panels & Batteries	23	42
Station & Vacuum Pumps	1	101
Cost Margin	30	50
Total	534	1,465

These increases yield an overall system cost of \$6.6-11.2 billion. This price would allow for a Downtown SF – downtown LA trip in 40 minutes, delivering a clear value proposition for commuters between the two cities.

Expanding Capacity

Given the design capacity (assuming 160 capsules is max capacity) the maximum hourly passengers that could be transported at 100% utilization would be 6,850 passengers via Hyperloop. Given that CHSR is slated to cost \$68 billion and can transport 24,000 passengers in both directions at peak capacity, Hyperloop must cost 28% or less of CHSR to be more efficient on a capital cost/peak passenger capacity basis. From this relationship it is clear that as long as Hyperloop costs less than \$20 billion, it is a more efficient option on a capital cost capacity basis.

Further, by adjusting the initial design to allow for longer capsules, overall system capacity can be dramatically increased – as capacity of each pod increases by 5 passengers, overall system capacity increases by 15%. This would lead to increased capsule, station, pylon, and propulsion and power costs; however, all other costs would remain fixed. As these costs represent roughly 50% of the overall Hyperloop system, and would in most cases increase linearly (in the worst case), system costs would increase by <7.5% for every 15% increase in

capacity.

Further, should an increase in capsule size not be possible, the Hyperloop line could be twinned (essentially building a new Hyperloop beside the current one) with overall system costs essentially doubling (with the potential exception of land acquisition costs).

Next Stop

Analysis of Hyperloop’s capital costs is only the first step in a full feasibility analysis. Clearly Musk’s cost estimates are optimistic, so the question becomes, how realistic is a \$20 ticket price? I will address this question in my follow-up blog post.

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Michael
Zawalsky

HBA/BESc 2014



Michael Zawalsky holds an Integrated Engineering degree from Western University (Gold Medalist) and a HBA from Ivey Business School (Dual Degree Gold Medalist). Michael previously sat on the IBR Editorial Board and filled the role of Publisher. He currently works as an Analyst at the Canada Pension Plan Investment Board (CPPIB). All opinions are his own.

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